AUTOMATION AND MECHANIZATION OF PRODUCTION

UDC 666.1.022

MEASURING AND MIXING SMALL COMPONENTS OF THE GLASS BATCH

V. V. Efremenkov[1] and K. Yu. Subbotin[1]

Translated from *Steklo i Keramika*, No. 9, pp. 3 – 4, September, 2008.

The characteristics of batching decolorizing agents and preparing premixes with different fillers (sand, soda, feldspar) based on them were examined. An algorithm for batching Se and CoO is proposed and allows eliminating adhesion of these materials to the bottom of the rotating pan in the tensiometric weigher.

The small components of a glass batch, i.e., the components contained in the batch in an insignificant amount, for example, selenium, cobalt oxide, and other decolorizing agents in the glass melt, are usually weighed and fed into the mixer in the preliminary mixtures — premixes. The probability of uniform distribution of these materials in a 1500 – 3000 liters batch mixture fed directly into the mixer is lower than for multistage mixing, so that Se and CoO are first mixed with sand, soda, feldspar, and other materials [1].

The use of feldspar as premix filler in some modern component shops is due to the good friable properties of the preliminary mixture obtained and the characteristics of the process configurations of the batching-mixing lines (BML), where the feldspar feed bins are usually located in the immediate vicinity of the mixing sections and premix preparation areas, which facilitates mechanical feed of feldspar from the feed bin to the corresponding filler batcher.

Sometimes there is no filler batcher, and the premix mixer, installed on tensiometric weighing sensors that control filling of the mixer with the given amount of filler and subsequently unloading it, is used as the weigher. Such control is expedient if soda is used as the filler, as it can stick to the walls and blades of the mixer and be incompletely unloaded into the feed bin during mixing with Se and CoO.

There are no specific recommendations with respect to the physicochemical processes in glass melting concerning selection of feldspar or soda as the filler. We know that in production of container glass, when the oxidative potential of the glass melt is insufficient, different forms of selenium can form and give the glass brown and black tints. Soda very actively absorbs selenium dioxide, creating more thermostable compounds which can react with silicon dioxide and form elemental selenium that turns the glass pink and together with cobalt compensates for the greenish tints from iron oxides [2]. Since the basic iron oxide content is in the sand and the accuracy of batching sand is on average higher than the accuracy of batching soda, it is expedient to use sand as the premix filler; in contrast to soda, it does not tend toward caking, sticking, or bridging and has more stable physicochemical characteristics.

Premixes can be prepared manually in laboratory conditions and in semiautomatic and automatic BML operating modes. In the semiautomatic mode, Se and CoO are weighed in laboratory conditions on an electronic balance and manually fed into the premix mixer previously semiautomatically or automatically loaded with the filler. After a given mixing time, the premix is unloaded into the corresponding feed bin.

The number of premix preparation cycles N_{PC} is a function of the output of the BML P_{BML}, the weight of the batch portion W_b prepared in one cycle (batch) of batch mixer operation, the weight of the premix portion W_{pr} prepared in one cycle of operation of the premix mixer, and the weight of the weighed portion of premix W_{PP} loaded into the basic mixer in each glass batch preparation cycle:

$$N_{PC} = \frac{N_{BC}}{N_{PP}}, \qquad (1)$$

where $N_{BC} = \dfrac{P_{BML}}{W_b}$ is the number of operating cycles (batches) of the batch mixer a day; $N_{PP} = \dfrac{W_{pr}}{W_{PP}}$ is the number of batches of the preliminary mixture obtained in one premix preparation cycle.

[1] Stromizmeritel' Co., Nizhny Novgorod, Russia.

0361-7610/08/0910-0293

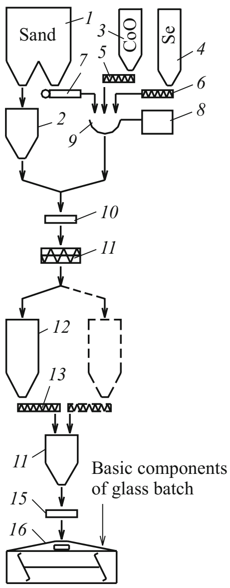

Fig. 1. Diagram of the batcher-mixer complex for preparation of premixes.

Substituting the values of N_{BC} and N_{PP} in Eq. (1), we obtain:

$$N_{PC} = \frac{P_{BML} W_{PP}}{W_b W_{pr}}. \quad (2)$$

We see from Eq. (2) that at a given BML output and given batch mixer output, the number of premix preparation cycles will basically be a function of the weight and number of premix portions prepared per cycle. For example, in production of 600 tons of batch a day, the weight of the batch portion prepared per mixing cycle is approximately 3 tons, while the required amount of selenium and cobalt oxide in such a batch will vary within the limits of 15 – 20 and 1.5 – 2 g. The optimum premix mixer volume for the given amount of decolorizing agents and 4-kg weight of weighed portions is equal to 75 – 100 liters (100 – 150 kg of sand-based premix), which corresponds to 25 – 37 portions of premix. For $N_{BC} = 600/3 = 200$ and $N_{PP} = 100/4 = 25$, we obtain $N_{PC} = 200/25 = 8$.

The weight of the Se and CoO fed into the premix mixer in preparation of a batch of 25 portions is 375 – 500 and 37.5 – 50 g, respectively.

For $N_{PC} = 8$ in the semiautomatic operating mode, it will probably be necessary to prepare 8 portions of Se and 8 portions of CoO in laboratory conditions, and they must then be manually loaded 8 times at certain premix mixer operating times. Since one premix preparation cycle is 2 – 4 min long, the entire operation for preparation of a one-day premix reserve will be a minimum of 30 min without consideration of the time for weighing the Se and CoO in the laboratory.

Since the premix preparation system operating in the semiautomatic mode can only fix the amount of loaded portions based on the operator's signal (for example, with a remote control button) and does not control the order and weight of the loaded portions of Se and CoO, such a system is less efficient than the automatic system and is subject to errors related to the human factor.

Different premix preparation batcher-mixer complexes that operate in the automatic mode have been developed and manufactured at Stromizmeritel' Co. The existing batcher-mixer complex [3] consists of spiral screw feeders for the selenium and cobalt oxide, a vibrating feeder for the sand, a tensiometric batcher with a rotating weighing pan, a premix mixer, a mixture feed bin, a spiral screw feeder, and a tensiometric premix weighing batcher.

Since the capacity of the premix mixer is equal to 6 liters and the output of the complex is a maximum of 50 – 60 kg/h of mixture, these complexes should not be used on high-output BML with batch mixers with a capacity greater than 1500 liters, since they do not allow batching a portion of premix weighing more than 1 kg in one cycle. Adding the premix in partial batches to a 3000-liter mixer, for example, increases the overall duration of batch preparation and decreases the quality.

The diagram of the updated premix preparation complex (see Fig. 1) developed at Stromizmeritel' Co. and designed for a BML with a capacity of 600 – 800 tons of batch a day contains filler bin 1 (sand), filler batcher *2* (sand), selenium feed bin *3*, cobalt oxide feed bin *4*, cobalt oxide screw feeder *5*, selenium screw feeder *6*, vibrating sand feeder *7*, selenium and cobalt oxide tensiometric batcher *8* with rotating pan *9*, disk loading batcher *10*, premix mixer *11*, premix bin *12*, premix screw feeder *13*, premix batcher *14*, premix loading butterfly gate *15*, and batch mixer *16*. Additional sand batcher *2* and a premix mixer with a capacity of 75 – 100 liters are differences between this scheme and the schemes for premix preparation previously used in Stromizmeritel' Co. projects. Based on our proposal, the Se and CoO batching algorithm was also altered and included an additional operation of weighing the sand in the rotating pan before feeding the glass melt decolorizing agents into it.

Since selenium and cobalt oxide have high adhesive characteristics, some of these materials stick during batching and unloading and remain on the bottom of the rotating pan, reducing the accuracy of weighing. To eliminate this, 200 – 300 g of sand in which Se and CoO had already been batched is fed onto the bottom of the rotating pan first with vibrating feeder *7*. When the pan rotates during unloading, Se and CoO together with the sand easily slides off and does not soil its surface. The sand is thus batched twice in this scheme — most is fed into the mixer by premix filler batcher *2*, and a smaller part (less than 1%) is fed by selenium and cobalt oxide batcher *8*.

A similar complex was introduced and is successfully operating at Malinovskii Glass Container Works (Khar'kov Oblast).

Further optimization of the operation of the batcher-mixer complex involves separate preparation of Se and CoO premixes. In this case, the premixes (CoO and Se) are alter-

nately prepared in mixer *11* (a scheme with two mixers is possible) and after discharge with a two-way switch, they are unloaded into the corresponding bins. Separate subsequent weighing of the premixes allows flexibly varying the ratio of Se and CoO in the batch and more accurately regulating decolorizing of the glass melt if the iron oxide content in the raw materials and cullet changes and the redox potential of the glass-melting furnace fluctuates.

REFERENCES

1. V. V. Efremenkov and V. P. Chalov, “Optimizing glass batch preparation,” *Steklo Keram.*, No. 2, 3 – 4 (2000).
2. V. A. Fedorova, “Glass tints and decolorizing — two sides of the same coin,” *Stekl. Tara*, No. 2, 1 – 2 (2004).
3. V. V. Efremenkov, and K. Yu. Subbotin, “Improving batching of small components of the glass melt,” *Steklo Keram.*, No. 1, 3 – 4 (2001).